PATENT APPLICATION

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D. Scott
9-28-01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Erez BRAUN et al.

Group Art Unit: 2815

Application No.: 09/462,171

Examiner: J. Jackson, Jr.

Filed: March 27, 2000

Docket No.: 104946

For: MICROELECTRONIC COMPONENTS AND ELECTRONIC NETWORKS COMPRISING DNA

REQUEST FOR RECONSIDERATION

Director of the U.S. Patent and Trademark Office
Washington, D.C. 20231

Sir:

In reply to the Office Action mailed March 20, 2001, Applicants request reconsideration of the application in view of the following remarks.

Claims 1-31 are pending herein. By the Office Action, claims 1-31 are rejected.

In the Office Action, claims 1-31 are rejected under 35 U.S.C. §112, first paragraph; and under §§102(b) and 103(a).

35 U.S.C. §112, First Paragraph, Rejections

The Office Action asserts that claims 1-31 contain matter which was not described in the specification in such a way as to enable one skilled in the art to make and/or use the invention. The rejections were aimed specifically at the following elements: p/n junction devices; combined semiconductor and organic base pair structure; field effect device with narrow DNA/metal gate; gate groove; source/drain/gate regions alignment; single molecule thickness; and single electron transistor device. Applicants respectfully traverse the rejections.

The test for enablement is whether one of ordinary skill in the art can make and use the claimed invention without undue experimentation in light of the application disclosure coupled with

the information known in the art. United States v. Telectronics, Inc., 8 USPQ2d 1217 (Fed. Cir. 1988). A patent may be enabling even though some experimentation is necessary, as long as the amount of the experimentation is not unduly extensive. Utter v. Hiraga, 6 USPQ2d 1709, 1714 (Fed. Cir. 1988). In describing the claimed invention, Applicants are not required to explain every detail since they are speaking to those of ordinary skill in the art. In re Howarth, 210 USPQ 690, 691 (CCPA 1981). That is, a patent need not teach, and preferably omits, what is well known in the art. Spectra-Physics v. Coherent, 3 USPQ2d 1737, 1743 (Fed. Cir. 1987).

Applying the above principles to the present application clearly indicates that the present application is fully enabled for the full scope of the claims. Applicants respectfully submit that the claimed invention is properly and fully enabled by the present specification. In particular, the present specification provides one of ordinary skill in the art with the necessary description of how to make and use the claimed invention. The present disclose, combined with the knowledge that one of ordinary skill in the art is presumed to have, would enable one of ordinary skill in the art to make and use the claimed invention without undue experimentation.

The invention is directed to an electric network comprising fibers formed from nucleotide chains bound to a substance which imparts the fibers with an electric or electronic property to form functionalized fibers. The fibers are connected to an electrically conducting interface component for electric communication with an external electric component or circuitry.

p/n Junction Devices

The formation of p/n junctions represents one embodiment of the present invention. Specifically, they represent an example of "one or more substances ... bound [to the nucleotide fiber] to form at least one ... conductor." Claim 1. However, the formation of p/n junctions is not essential for executing the invention claimed in claim 1.

In one embodiment of the invention, single-stranded nucleotide linkers are attached to electrodes via the disulfide groups of the linkers. DNA having sticky ends complementary to

the sequences of the linkers binds to the linkers and forms a bridge between the two electrodes. Page 24, lines 11-26. Fig. 3A/1.

Functionalization of the above-described fiber, as is defined on page 6 of the specification, is the chemical or physical attachment of substances onto the fiber that impart electric or electronic properties to all or part of the fiber. One example of functionalization of the above-described fiber is to replace the ions of the fiber's nucleotide chain (i.e., the nucleotide bridge between the electrodes) with metal ions. Upon subsequent treatments, a wire is formed. Page 25, line 12 - page 26, line 10. A wire is defined on page 7 as a functionalized fiber with bound substances or particles that give rise to electrical conductivity along the fiber. In addition to metal, other substances can be used to functionalize the fiber, including PPV and polyaniline. Page 27, lines 6-7 and page 28, lines 5-6, respectively. Polyaniline polymers include polymers with an electron deficiency (p-type polymers) or an electron surplus (n-type polymers). Page 28, lines 6-7.

When using p-type and n-type substances to functionalize fibers, each of these polymers are individually bound to two separate oligonucleotides. One of ordinary skill in the art would know how to bind the p-type and n-type substances to the oligonucleotides. The two oligonucleotide sequences (individually bound to the p-type and n-type substances) are then hybridized to their respective complementary DNA sequences (i.e., nucleotide linkers) on adjacent portions of the fiber. One of ordinary skill in the art would also know both how to select oligonucleotides complementary to the linkers of the fiber, and exactly how to carry out the hybridization reaction. The resulting device, with p-type and n-type substances bound to adjacent portions of the fiber, has a p/n junction that can serve as a diode. Page 28, lines 13-26.

One of ordinary skill in the art would be able to form the electrical network of claim 1 based on the disclosure in the specification. Further, one of ordinary skill in the art would be able to form a specific embodiment of the electrical network of claim 1 wherein the electrical

conductor is formed by binding p-type and n-type substances to at least one fiber to form the electrical network.

Combined Semiconductor and Organic Base Pair Structure

After assembling the p/n type substances to two different oligonucleotides, one of ordinary skill in the art would be able to carry out the hybridization reaction and subsequent treatment to form the combined semiconductor and organic base pair structure as seen in Fig. 5 of the specification. Page 28, lines 10-18.

Field Effect Device, DNA/Metal Gates, Gate Groove

One of ordinary skill in the art would be able to form a conventional field effect transistor with a conventional metal gate and gate grooves. Further, one of ordinary skill in the art would be able to align the source/drain/gate pads in accordance with conventional microelectronic techniques. See, for example, S.N. Sze, Physics of Semiconductor Devices, 2nd Edition, John Wiley and Sons, 1981, pages 349 and 490-495, a copy of which is attached hereto.

The present invention uses a DNA based wire to replace the conventional metal gate. DNA based wires are more narrow than any wire that could be formed by conventional microelectronics, thus presenting a substantial advantage over existing metallic gates. The field effect transistor may be fabricated by conventional lithography and semiconductor processes, including the etching of gate groove and electrode alignment. The DNA based gate wire itself is aligned by the microelectronically-defined electrodes and stretched between them as described in detail in the specification. Page 33, line 18 - page 34, line 4. Fig. 12. One of ordinary skill in the art would be able to combine preparation of a conventional field effect transistor with the DNA based gate wire taught in the specification.

Single Molecule Thickness

Although it is possible that structures formed by adjacent n-type polymers and p-type polymers that are of single molecule thickness may not function in the same manner as thicker structures, such substance thickness was never defined or claimed in the application. Rather, the

specification shows that the p/n junction may have different "doping's" resulting from different thicknesses of the p/n junction forming substances. Page 29, lines 12-18. Accordingly, whether or not single molecule thickness devices operate in the same manner as thicker devices is irrelevant to the question of enablement of the claimed invention.

Single Electron Transistor Device

The formation of single electron transistors using colloid particles is known to one of ordinary skill in the art. See, for example, Klein et al., Sato et al. and Natan et al., copies of which are attached hereto. In particular, the publication by Klein demonstrates that alkane chain molecules may act as electron tunneling barriers while cluster particles (semiconductor substances) act as an electron localization site. The formation of a single electron transistor device is described in detail in the specification. Page 30, line 9 - page 31, line 9. Examples 13 and 14. In addition, an atomic force microscope image of the result of the manipulation described is provided in Fig. 17 of the specification.

Summary

Clearly, for at least the reasons stated above, one of ordinary skill in the art would be able to use the disclosure of the specification to form the elements cited in the Office Action, and could thus make and use the claimed invention. Reconsideration and withdrawal of the rejections are respectfully requested.

Rejections Under §§102 and 103

The invention as claimed in independent claim 1 relates to an electric network comprising at least one fiber comprising a nucleotide chain defining the network's geometry; and one or more substances, molecules, clusters of atoms or molecules or particles bound thereto or complexed therewith to form at least one electric or electronic component or a conductor; the network being electrically connected to an electrically conducting interface component for electric communication with an external electric component or circuitry. Independent claim 28 is directed to a method for making such an electronic network, comprising (a) providing an

arrangement comprising at least one electrically conductive interface component; (b) attaching a linker to the at least one interface component; (c) contacting said arrangement with at least one fiber comprising at least one nucleotide chain with a sequence capable of binding to the linker, and permitting binding of said sequences to said linker; (d) electrically or electronically functionalizing the at least one nucleotide chain by depositing thereon or complexing thereto at least one substance or particles. Such an electric network, and method for making such an electronic network, is not anticipated by, and would not have been obvious over, the cited references.

In the Office Action, claims 1-31 were rejected over the cited references inasmuch as the claims can be limited to "wires." However, Applicants respectfully submit that the rejections are improper as improperly considering the claimed invention. In particular, the claims are not limited to "wires" as asserted in the Office Action. Rather, as described above, the claimed invention is directed to "an electric network comprising at least one fiber . . . to form at least one electric or electronic component or a conductor; the network being electrically connected to an electrically conducting interface component for electric communication with an external electric component or circuitry." (Emphasis added.)

In order to properly reject the claims as being anticipated by or as having been obvious over the cited references, the Patent Office must consider all of the claim limitations. It is improper for the Patent Office to characterize the claims in such as way as to exclude and ignore express claim limitations. Proper consideration of the claims demonstrates that the claimed invention is in fact patentable over the cited references.

A. Mirkin

Claims 1-31 are rejected under 35 U.S.C. §102(b) or §103(a) over Mirkin. Applicants respectfully traverse this rejection.

Mirkin et al. describes the control of colloid aggregation by attaching to the surfaces of two batches of gold particles non-complementary DNA oligonucleotides capped with thiol

groups (isolating substances), which bind to gold, and mixing therewith DNA with "sticky ends" that are complementary to the two above sequences, to form self-assembled nanoparticle aggregates. Mirkin does not describe the fabrication of wires, nor does it describe the formation of conductive organic DNA to form electronic or electric components. Further, Mirkin does not teach or suggest the connection of the components to an electrically conducting interface component for electric communication with an external electric component or circuitry, i.e., to form the electric network of the invention. No electrically conducting wires are formed, and there is no motivation within the reference or elsewhere to connect the assemblies formed to electrically conducting interface components (such as electrodes), being connected to an electric source to form an electric network.

Thus, Mirkin fails to anticipate the claimed invention. Moreover, it would not have been obvious to one of ordinary skill in the art to modify the disclosure of Mirkin to achieve the desired electrical network of the claimed invention.

Accordingly, the claimed invention is patentable over Mirkin. Reconsideration and withdrawal of the rejection are respectfully requested.

B. Coffer

Claims 1-31 are rejected under 35 U.S.C. §102(b) or §103(a) over Coffer. Applicants respectfully traverse this rejection.

Similarly, Coffer discloses a method for forming deliberate mesoscale patterns of semiconductor nanoparticles using the size and shape of a DNA molecule (the plasmid pUCLeu 4) to dictate the overall structure of the assembly. Coffer does not teach or suggest the fabrication of wires, nor does it describe the formation of conductive organic DNA to form electronic or electric components. Further, Coffer does not provide motivation to connect the components to an electrically conducting interface component for electric communication with an external electric component or circuitry, i.e., to form the electric network of the claimed invention. No electrically conducting wires are formed, and it would not have been obvious to

one of ordinary skill in the art to modify the Coffer assemblies to form the electric networks of the claimed invention.

Thus, Coffer fails to anticipate the claimed invention. Moreover, it would not have been obvious for one of ordinary skill in the art to modify the disclosure of Coffer to achieve the desired electrical network of the claimed invention.

Accordingly, the claimed invention is patentable over Coffer. Reconsideration and withdrawal of the rejection are respectfully requested.

C. Mirkin or Coffer in view of Hopfield

Claims 1-31 are rejected under 35 U.S.C. §103(a) over Mirkin or Coffer in view of Hopfield. Applicants respectfully traverse this rejection.

As described above, neither Mirkin nor Coffer alone anticipate or would have rendered obvious the claimed invention. Both references fail to teach or suggest the claimed electric network being electrically connected to an electrically conducting interface component for electric communication with an external electric component or circuitry. Hopfield fails to overcome the above-described deficiencies of Mirkin and Coffer.

Hopfield et al. discloses the fabrication of an electronic shift resistor memory which is based on a chain of electron transfer molecules and shift of information by photoinduction. In particular, the polymer chains employed therein comprise a plurality of monomeric repeat units having different excitation states. As a result of exposure of the polymer to a short intense burst of light, all electrons will move from one unit to another unit to form the molecule shift register.

Hopfield does not teach or suggest the use of functionalized fibers (nucleotide chains bound to electric or electronic components to form the wires), nor does it teach or suggest the claimed electrical conducting network. Further, Hopfield teaches away from the claimed invention by disclosing electron transitions that are induced by light rather than by electricity. Thus, it would not have been obvious for one of ordinary skill in the art to modify the disclosure of Hopfield to achieve the claimed electrical network of the invention.

Neither Mirkin et al. nor Coffer et al., alone or in view of Hopfield, teach, suggest or would have rendered obvious using nucleotide chains as fibers that are functionalized by attachment of substances, clusters of atoms or molecules to impart electric or electronic properties to the fiber, thereby forming an electronic wire of a circuit which are themselves connected to an electrically conducting interface component (such as electrodes) for electric communication with an external electric component or circuitry, to form the electric network of the claimed invention. Reconsideration and withdrawal of the rejection are respectfully requested.

Conclusion

In view of the foregoing remarks, Applicants respectfully submit that claims 1-31 are in condition for allowance. Favorable consideration and prompt allowance of the application are respectfully requested.

Should the Examiner believe that anything further is necessary in order to place the application in even better condition for allowance, the Examiner is invited to contact the Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

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Attachments:

S.N. Sze, Physics of Semiconductor Devices, 2nd Edition, pages 349 and 490-495
Klein et al.
Sato et al.
Natan et al.

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